Bonneville Power Administration
Fish and Wildlife Program FY99 Proposal

Section 1. General administrative information

Flathead River Instream Flow Project

Bonneville project number, if an ongoing project 9502500

Business name of agency, institution or organization requesting funding
Montana Fish, Wildlife & Parks - Subcontract

Business acronym (if appropriate) MFWP

Proposal contact person or principal investigator:

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Subcontractors.

Organization	Mailing Address	City, ST Zip	Contact Name
This project will be entirely subcontracted directly by BPA	Subcontractor will be selected via RFP		

NPPC Program Measure Number(s) which this project addresses.
10.2A.2, 10.2B, 10.3A.1, 10.3A.2, 10.3A.3, 10.3A.4, 10.3A.6, 10.3A.9, 10.3A.11, 10.3A.18.

NMFS Biological Opinion Number(s) which this project addresses.
NMFS Hydrosystem Operations for salmon recovery (56 FR 58619; 57 FR 14653)
Bull Trout Proposed Listing (62 FR 32268)
Westslope cutthroat trout and bull trout recovery actions

Other planning document references.
Brannon 1985; Flathead Basin Commission 1995, 1997; Hungry Horse Mitigation Plan (1991); Hungry Horse Implementation Plan (1993); May et al. (1988); Knotek et al.

(1997); Montana Bull Trout Restoration Team (1997);Montana Bull Trout Scientific Group (1995). Montana Stream Protection Act (1963). Natural Streambed and Land Preservation Act (1975).

Subbasin.
Flathead Subbasin - Upper Columbia; Flathead River main stem.

Short description.
Conduct IFIM study on Flathead River from South Fork confluence to Flathead Lake. Determine effects of flow fluctuations on fish habitat, predator prey interactions, sediment deposition and fish migrations. Link river model to reservoir model (HRMOD).

Section 2. Key words

Mark	Programmatic Categories	Mark	Activities	Mark	Project Types
	Anadromous fish		Construction	+	Watershed
X	Resident fish		O & M	+	Biodiversity/genetics
	Wildlife		Production	+	Population dynamics
	Oceans/estuaries	X	Research	+	Ecosystems
	Climate	+	Monitoring/eval.	X	Flow/survival
	Other	+	Resource mgmt		Fish disease
			Planning/admin.		Supplementation
			Enforcement		Wildlife habitat enhancement/restoration
			Acquisitions		

Other keywords.
Fluvial dynamics, hydropower operations, flood control, flow ramping, Instream Flow Incremental Method.

Section 3. Relationships to other Bonneville projects

Project #	Project title/description	Nature of relationship
9401000	Excessive Drawdown Mitigation - Hungry Horse Reservoir	Compiles microhabitat and fisheries data to complement and extend this IFIM project which completes the physical model framework
9101901	Hungry Horse Fisheries Mitigation - Confederated Salish and Kootenai Tribes	Shares experience from similar project completed in the lower Flathead River
9101903	Hungry Horse Mitigation - Habitat Improvements	Runs array of thermal sensors in Flathead River, shares data and occationally personnel.
9608701	Flathead Focus Watershed	Watershed Coordination

8346700	Libby Reservoir Mitigation	Shares experience from completed IFIM project on the Kootenai River
8346500	Libby and Hungry Horse Modeling Technical Analysis	Links IFIM model resulting from this project to the existing reservoir model (HRMOD)

Section 4. Objectives, tasks and schedules

Objectives and tasks

Obj 1,2,3	Objective	Task a,b,c	Task
1	Develop comprehensive spatial and tabular/attribute database (IFIM models) to characterize physical processes in the Flathead River affected by flow from Hungry Horse Dam	a	Compile spatial database (GIS map) of the Flathead River from the South Fork confluence downstream to Flathead Lake
1		b	Integrate smaller scale information on riparian land use and vegetation, macro-habitat classification, thermal modeling results and hydrographic modeling results.
1		c	Integrate detailed channel topography for micro-habitat and sediment transport modeling
2	Use IFIM models to compare the results of alternative dam operational strategies on aquatic resources	a	Develop an array of potential scenarios for managing river flows to meet biological objectives
2		b	Determine cost-effective operation to minimize predation of juvenile bull trout and westslope cutthroat trout by lake trout and northern squawfish
2		c	Determine the magnitude, timing and duration of the peak flow event needed to move fine sediments to enhance aquatic production
2		d	Establish flow ramping rates to minimize riparian vegetation loss due to bank failure and lateral

			migration

Objective schedules and costs

Objective #	Start Date mm/yyyy	End Date mm/yyyy	Cost %
1	4/1998	12/2000	75.00%
2	1/2000	3/2001	25.00%
			TOTAL 100.00%

Schedule constraints.
This project was scheduled to begin in FY97 and run for three years. However, the project could not be launched until 1998 and was deferred until FY98. A draft RFP was submitted to BPA so that solicitation of proposals can be initiated in spring 1998.

Completion date.
2001

Section 5. Budget

FY99 budget by line item

Item	Note	FY99
Personnel		
Fringe benefits		
Supplies, materials, non-expendable property		
Operations & maintenance		
Capital acquisitions or improvements (e.g. land, buildings, major equip.)		
PIT tags	# of tags:	
Travel		
Indirect costs		
Subcontracts	Project will be 100 percent subcontracted	100,000
Other		
TOTAL		$100,000

Outyear costs

Outyear costs	FY2000	FY01	FY02	FY03

Total budget	$100,000	$33,000	$ 0	$ 0
O&M as % of total	0.00%	0.00%	0.00%	0.00%

Section 6. Abstract

Construction of Hungry Horse Dam on the Flathead River (completed in 1952), caused many physical and biological changes in the Flathead River downstream. Hypolimnetic releases from the dam artificially cooled the river from 1952 through 1996 when a selective withdrawal structure was installed on the dam, allowing dam operators to control the water temperature in the tailwater. Now that the thermal pollution from Hungry Horse Dam can be mitigated, a primary manageable threat to watershed health is dam operation. Flow fluctuations from power and flood control operations create an extensive, low productivity, varial zone, greater substrate imbeddedness and species shifts in the aquatic insect community which has become less diverse and less productive. A combination of man-caused factors resulted in the decline in native gamefish species mountain whitefish, westslope cutthroat and bull trout, and a significant increase in abundance of non-game native species, the Columbia River chub or peamouth, northern squawfish and introduced rainbow trout and northern pike . Pursuant to measure 10.3A.18 of the FWP, this project will use a modified form of the Instream Flow Incremental Methodology (IFIM) to examine the mechanisms by which dam operation effects the riverine community and their environment, and propose operational guidelines to mitigate negative effects. Results will expand the utility of the existing reservoir model HRMOD, verify and refine the Integrated Rule Curves developed for Hungry Horse Dam. This project will be directly contracted by BPA through competitive bid.

Section 7. Project description

a. Technical and/or scientific background.

Hungry Horse Dam (completed in 1952), caused many physical and biological changes in the Flathead River downstream (Appert and Graham 1982, Fraley and Decker-Hess 1987, Fraley and Graham 1982, Fraley et al. 1986, Fraley et al. 1989, Hall et al. 1989). Hypolimnetic releases from the dam artificially cooled the river and caused rapid temperature fluctuations from 1952 through 1996. In August 1996, a selective withdrawal structure was installed on the dam allowing dam operators to control the water temperature in the tailwater (Marotz et al. 1994; Christenson et al. 1996). Now that the thermal pollution from Hungry Horse Dam can be mitigated, a primary manageable threat to watershed health is dam operation. Power and flood control operations have essentially reversed the natural hydrograph by storing the spring melt in the reservoir, and then releasing water for power production during the cold months when natural flows are normally low. Short term flow fluctuations caused by power operations create an extensive, low productivity varial zone, greater substrate imbeddedness and species shifts in the aquatic insect community which has become less diverse and less productive (Hauer et al. 1994). River flows and flow fluctuations also cause important changes in habitat availability and fish movements (Cushman 1985; Dalbey et al. 1997). A combination of man-caused factors resulted in the decline in native gamefish species, mountain whitefish, westslope cutthroat and bull trout, and a significant increase in abundance of non-game native species, the Columbia River chub or peamouth, northern squawfish and introduced rainbow trout.

An annual flow regime with tolerable flow fluctuations is needed to maximize the effectiveness of the selective withdrawal structure and to balance riverine productivity with hydropower production and flood control. Measure 10.3A.18 of the NPPC Fish and Wildlife Program calls for consultations with MFWP and CSKT when conflict occurs between reservoir and river requirements. The goal is to restore normative conditions in the Flathead Watershed (ISAB 1997).

Since 1995, recovery actions for the endangered Snake River salmon, as directed by the NMFS Biological Opinion for ESA listed Snake River salmon (NMFS 1995), have influenced the timing of water released from Hungry Horse Dam. Specifically, summer releases of reservoir storage, to augment downstream flows, have caused unnatural flow fluctuations in the Flathead River during the productive summer months. Unless we understand the effects of these releases, recovery actions may counter or reverse mitigation efforts to balance the needs of resident and anadromous fish (ISAB 1997b).

This project will use a modified application of Instream Flow Incremental Methodology in three reaches of the Flathead River (e.g. PHABSIM and HABSP). The first reach beginning at the South Fork confluence and extending downstream 20 miles is mostly homogeneous with some island complexes. At this point the river becomes a braided, depositional area with added inflow from the Stillwater River, designated reach 2. The third reach extends from this braided section to the mouth on Flathead Lake and is characterized by low gradient and seasonal backwater effects from the lake impounded by Kerr Dam. The entire river segment downstream of Hungry Horse Dam will be mapped using GIS technology to document detailed changes over time. Larger scale attributes within the three reaches will be extrapolated from detailed measurements of river morphology, hydrography, sediment typing and habitat parameters. Microhabitat use by fish life stage will be compiled by project 9401000 and overlaid on the framework provided by this project. Target species include bull trout, westslope cutthroat and northern squawfish (native), lake trout and northern pike (non-native). Acceptable flow ramping rates will be established seasonally (due to the presence or absence of critical life stages of resident fish).

To accomplish these goals, the selected contractor will establish IFIM transects for hydraulic measurements in each river reach. The contractor will initiate collection of depth, water velocity profiles, substrate type and cover at established cross-sectional points at all transects, and compile and proof data sets. Stream mapping and profiling will use GIS technology, digitized from low elevation areal photography and forward scanning hydroacoustics. The project will move from macro to microhabitats during the three-year project.

Dynamic temperature modeling using selective withdrawal (Marotz et al. 1994) will be restructured to mesh with this projects objectives to improve conditions for native trout. Longitudinal thermal monitoring is ongoing under project 9101903. Refinement of the existing thermal model to provide greater longitudinal resolution will be accomplished under project 8346500.

An optimization program to link the river IFIM and the reservoir model HRMOD (Marotz et al. 1996), will draw heavily from modeling nearing completion in the Kootenai system (Dalbey et al. 1998, in prep). Modeling typically uses the simplest mathematical tools to make maximal use of available empirical data. Project design and statistical analyses will be reviewed/edited by University statistical consultants.

Data will be incorporated in a modified IFIM based river model capable of assessing hydraulic and thermal parameters over the range of flows observed in the study area. The project report will recommend an annual regime of flows and allowable flow fluctuations to balance riverine fish production with hydropower generation. Project 8346500 will link the river model with the existing reservoir model HRMOD to assess tradeoffs when reservoir and river requirements conflict.

Monitoring of the effectiveness of dam operations resulting from this project is planned under CBFWA approved, project 9501200 which can not begin until operational changes have been implemented.

b. Proposal objectives.

1. Update digitized GIS map of the Flathead River from the South Fork confluence to the mouth on Flathead Lake. Include land use and vegetative typing of shoreline habitats. The Flathead was previously mapped using areal photography and digitization. Comparison of the former map with the updated map will identify areas of rapid change.

2. Overlay topographical attributes, river gradient, channel morphology, cover and land/substrate forms. River flows will be calculated at points downstream from the Hungry Horse Dam. Hydraulic calculations representing the main stem Flathead River will quantify the combined discharge at the confluence with the South Fork and Stillwater Rivers.

3. Within each of three river reaches, calibrate IFIM submodels to describe hydraulic conditions under various flow volumes. Simulate changes in physical habitat conditions at flows of interest. This methodology assumes that habitat conditions within a reach are mainly homogenous so that detailed measurements in one portion of the reach can be extrapolated to the whole. This can be accomplished by stratifying the reach by depth, channel form (e.g. single channel, island complex), morphometry, and substrate and cover classifications. Larger-scaled measurements are used to describe attributes within smaller-scale categories.

4. Provide dynamic three-dimensional framework on which to overlay the longitudinal thermal model. The thermal model already exists. Ongoing monitoring using an array of thermographs (by project 9101903) will increase the resolution of the model when overlaid on the hydraulic framework, thus increasing the utility of both models.

5. Relate biological functions to thermal, hydrographic and physical attributes. This component is considered the most difficult relationship to develop for large rivers. Given our experience applying this technique to the Kootenai River system, we acknowledge this difficulty and have taken steps to minimize modeling bias. We must assume apriori that the models can be calibrated to actual conditions in the field, so that simulations mimic real physical relationships. Empirical measurements of biological attributes are typically noisy, so mathematical relationships must be based on the best fit between the dependent and independent variables. This can typically be demonstrated graphically, within each model component, so that unrealistic results can be identified and corrected . Where results are counter-intuitive, additional samples can be collected to validate (or disprove) previously established relationships. Selection of a qualified contractor and continuing oversight by the MFWP liaisons during the data collection and analysis process are critical to the success of this project.

5. Use the river model to assess seasonal operational strategies. Recommend seasonal discharge schedules and ramping rates that maximize biological production while maintaining a balance with reservoir operations for power production and flood control. Recommendations will consider Hungry Horse Dam operations in the context of the Columbia System, a watershed. This involves multiple model runs across the range of expected (hydrologically possible) conditions, as influenced by downstrean dam operations (e.g. Kerr, Noxon, Cabinet Gorge, Albeni Falls etc.). Evaluate results to establish an
acceptable range of seasonal operations.

6. Document modeling methodology, analytical results, recommendations and user instructions in a detailed final report.

c. Rationale and significance to Regional Programs.

This project provides the physical framework for assessing physical and biological effects of various river operations in the Flathead System. It is a component of the larger Hungry Horse Mitigation Program addressing operational mitigation (Integrated Rule Curve refinement and assessment: measure 10.3A of the FWP). This project extends and complements previous efforts in reservoir and thermal modeling (projects 8346500 and 8346700 in the Flathead and Kootenai drainages), ongoing mitigation actions (projects 9101903 and 9401000), and will provide a tool for future monitoring actions (project 9501200). Results will help federal dam operators and fisheries managers balance dam operations for the greatest benefit, by balancing fisheries concerns with power production and flood control. The ability to assess tradeoffs between reservoir and river operations, both locally and systemwide, is especially important now that many Columbia River fish species have been petitioned or proposed for listing, or listed under ESA. Also, previous investments in hydropower mitigation should be protected, with special consideration when changes in system operation are implemented. Changes in dam operation for recovery actions in the lower Columbia have been shown to impact resident fish in the headwaters (ISAB 1997b) and must be balanced to benefit all native fish species. Actions taken, must also be affordable or the public will likely stop the effort. To do this, decision makers must have tools to assess tradeoffs and make wise choices.

Since 1982, we have completed and evaluated basin specific models in the headwaters of the Columbia River in Montana. An effort similar to this ongoing project will be completed in the Kootenai River during 1998. Results to date have played prominent roles in the Columbia Basin System Operation Review (reservoir screening model and subbasin analyses), Kootenai White Sturgeon Recovery Actions (IRCs and tiered flow approach), Watershed Equity Team (system analyses to balance resident fish needs with anadromous fish recovery), Al Wright Process (1996)(system evaluation to assess IRC and BiOp operations to find common goals and strike a balance between anadromous and resident fish), and periodic systemwide analyses (BPA's HYDROSIM, NPPC's SAM etc.).

This tool is applicable to other storage projects in the Columbia System given the necessary site-specific data. The Independent Scientific Group recommended that this tool be applied to other US subbasins containing storage projects (ISG 1996). Past experience has shown us how to speed the data acquisition and modeling process and reduce costs. It is now possible to qualitatively assess the biological effects of operational alternatives (i.e. develop simplified versions of IRCs) based on hydrology alone. Simplified screening models (as were used in the SOR process) can direct research efforts into the most critical areas, thus saving time and money. As a research program matures, empirical data can be incorporated into a quantitative model (similar to HRMOD and LRMOD). Decisions can be made with increasingly greater confidence and resolution as the model becomes more quantitative.

d. Project history

This project was evaluated and approved for funding by the Columbia Basin Fish and Wildlife Authority - Resident Fish Committee in 1996 and 1997. However, the project could not begin until 1998. Montana Fish, Wildlife & Parks and the Confederated Salish and Kootenai Tribes wish to have BPA contract this project directly with a qualified contractor. A draft Request For Proposals (RFP) has been submitted to BPA to initiate selection of a contractor. The project is planned for a three year term. Associated thermal and biological sampling is underway on separate contracts (projects 9101903 and 9401000).

e. Methods.

1. Digitized GIS map: low elevation areal photographs of the Flathead River from the South Fork confluence to the mouth on Flathead Lake will be digitized. A layer will include land use and vegetative typing of shoreline habitats. A comparative overlay with a previous GIS map will be used to identify areas of rapid change. Dynamic areas must be distinguished from stable areas when detailed attributes are extrapolated to larger areas within each reach (see below).

2. Overlay topographical attributes: River gradient will be measured using standard surveying techniques (laser transit and GPS station). Channel morphology will be measured in established transects and longitudinally using forward scanning hydroacoustics (Bovee 1982; Bovee and Milhous 1978; Milhous et al. 1989, 1984; Payne 1992; Rantz 1982). Substrate forms / cover will be measured at transects using SCUBA and sediment scoring techniques. The selected contractor will be allowed to specify and defend the details of specialized modifications.

River flows will be calculated at points downstream from the Hungry Horse Dam. Hydraulic calculations representing the main stem Flathead River will quantify the combined discharge at the confluence with the South Fork and Stillwater Rivers. Hungry Horse operations are recorded daily by the U.S. Bureau of Reclamation. Flow measurements from the U.S. Geological Survey allow for “real data” simulations using historical records, or hypothetical operations can be generated using regression relationships of simultaneously recorded flow data at various points along the river.

3. Calibrate IFIM submodels, simulate changes in physical habitat conditions at flows of interest: This methodology assumes that habitat conditions within a reach are mainly homogenous so that detailed measurements in one portion of the reach can be extrapolated to the whole. This can be accomplished by stratifying the reach by depth, channel form (e.g. single channel, island complex), profile / width and substrate classification so that larger-scaled measurements are used to describe attributes within small-scale categories.

4. Framework on which to overlay the longitudinal thermal model. The thermal model already exists (Marotz et al. 1994). Ongoing monitoring using an array of thermographs will increase the resolution of the model when overlaid on the hydraulic framework, thus increasing the utility of both models. The thermographs were placed to correspond with reach breaks in this IFIM project. The physical framework is described in items 1-3.

5. Relate biological functions to physical attributes: Empirical measurements of biological attributes are typically highly variable. Initial samples will be rapidly processed to determine how many samples are necessary to describe each variable. Without preliminary samples, it is impossible to estimate the degree of resolution necessary to provide meaningful modeling results. However, we anticipate that biological organisms will be obviously related to depth, velocity, substrate type and proximity to cover (Read et al. 1982; Shepard and Graham 1982; Weaver and Fraley 1991; Weaver and Fraley 1993; Weaver et al. 1983). Descriptions of microhabitat use

have already been developed in the Kootenai for many species (or life cycle phase) of interest (Dalbey et al. 1998, in prep). We will validate and adjust these earlier findings for use in the Flathead (Bovee 1978, 1986; Nehring 1992; Payne 1988). Mathematical relationships must be based on the best fit between the dependent and independent variables. This can typically be demonstrated graphically, by model component, so that unrealistic results can be identified and corrected. Where results are counter-intuitive, additional samples can be collected to validate (or disprove) previously established relationships.

5. Assess seasonal operational strategies: Flathead River species show obvious seasonality in life cycles, migrations and relative abundance. We assume that some periods of the year will be more sensitive than others and that acceptable range of flow fluctuation and rate of change will differ seasonally. To assess this relationship, multiple model simulations will be performed across the range of expected (hydrologically possible) conditions. Results will be used to establish an acceptable range of seasonal operations.

6. Document modeling methodology, analytical results, recommendations and user instructions in a detailed final report. A draft report will be submitted to MFWP, CSKT and experts in the field for peer review. Comments and suggestions will be incorporated in the final report to be published in full by BPA. Professional manuscripts will be developed by agreement between cooperators for submission to refereed journals.

f. Facilities and equipment.

The Contractor will provide facilities and equipment as part of their contract. MFWP will supply some minor equipment and support (projects 9101903 and 9401000).

g. References.

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Wright, A. 1996. Review of Columbia River operating criteria. Facilitators Report to National Marine Fisheries Service and Bonneville Power Administration. Al Wright Consulting, Portland, OR. 15 pp. (plus 17 pp. appendices)

Section 8. Relationships to other projects

This project is a component of the operational mitigation program for the construction and operation of Hungry Horse Dam (MFWP and CSKT 1991,1993), and mitigation actions for excessive drawdown at Hungry Horse Dam (project 9401000). Measurements of physical attributes in the Flathead River influenced by Hungry Horse Dam and IFIM modeling efforts are carried out by the selected contractor under this project. Biological data collection for this effort is performed by project 9401000. The thermal array in the Flathead River is monitored by project 9101903. Thermal modeling, and modeling of reservoir operations, and their interaction with river flows, are performed by project 8346500. Coordination of these related projects reduces costs and expands the effectiveness of each individual project. This overall effort could be viewed as a single project, but because of differing timelines and distinct responsibilities by cooperating parties, we have separated the components for administrative purposes.

Cooperation with the Bureau of Reclamation and BPA dam operators will be necessary at times to assure that flow conditions are suitable for physical and biological sampling. In the past, formal requests for short term operations have been submitted in advance to allow for appropriate flood control planning and power scheduling. The sampling design based on expected annual operations to minimize special requests

Resulting operational recommendations must be coordinated with Kerr Dam operating requirements dictated by the FERC relicencing agreement. Law requires that actions by Hungry Horse Mitigation and Kerr Mitigation Plans be coordinated. Local operations must also be coordinated with system operations from a Columbia Basin-wide perspective.

Section 9. Key personnel

Information on Key Personnel form the selected contractor will be compiled during the RFP and selection process.

The MFWP liaison overseeing the execution of this project and coordinating related projects is Brian Marotz.

BRIAN MAROTZ

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Education

Master of Science – Fisheries Management
Louisiana State University - Baton Rouge, Louisiana.
Estuarine Biology

15 Credits: Gulf Coast Research Institute
Ocean Springs, Mississippi.
Marine Science

Bachelor of Science – Biology (Aquatic Sciences)
University of Wisconsin - Stevens Point, Wisconsin.
Freshwater Biology

16 Credits: S.E.A. Semester at Sea, Boston University
Woods Hole, Massachusetts
Marine Biology

Professional experience

1991-Present Fisheries Program Officer, Montana Fish, Wildlife & Parks
Kalispell, Montana
Duties: Supervise Special Projects Office, Hydropower Mitigation and Focus Watershed Programs.

1989 – 1991 Fisheries Biologist, Montana Fish, Wildlife & Parks
Kalispell, Montana
Duties: Hungry Horse Reservoir Research, Develop Hungry Horse Mitigation Program, Computer Modeling Flathead and Kootenai Drainages, Develop Integrated Rule Curves (IRCs) for Montana Reservoirs.

1985 – 1989 Fisheries Biologist, Montana Fish, Wildlife & Parks
Libby, Montana
Duties: Libby Reservoir Research, Kootenai Instream Flow Project, Computer Modeling Flathead and Kootenai Drainages, Develop Integrated Rule Curves (IRCs) for Montana Reservoirs.

1984 – 1985 Research Associate, Louisiana State University - Baton Rouge, Louisiana
Duties: Estuarine Research to control salt water encroachment to Estuarine Marsh on the Sabine National Wildlife Refuge. Developed Operating Plan for Water Control Structures to Allow Migration of Catadromous Fish and Crustaceans

Publications Pertinent Publications Listed in this Document

Awards *1994* Governor's Award for Excellence in Performance as an Employee of the State of Montana. Received from Governor Racicot.

1994 Director's Award for Excellence as an Employee of Montana Fish, Wildlife & Parks. Received from Pat Graham.

1989 Certified Fisheries Scientist
American Fisheries Society

Section 10. Information/technology transfer

The Contractor report will be submitted to MFWP and BPA. Project results will be published in BPA reports and, where applicable, peer reviewed journal articles. Monthly or quarterly reports will be available to all agency and citizen groups.